

MSE3113: SOFT MATERIALS

Effective Term

Semester A 2025/26

Part I Course Overview

Course Title

Soft Materials

Subject Code

MSE - Materials Science and Engineering

Course Number

3113

Academic Unit

Materials Science and Engineering (MSE)

College/School

College of Engineering (EG)

Course Duration

One Semester

Credit Units

3

Level

B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction

English

Medium of Assessment

English

Prerequisites

Nil

Precursors

AP2102/MSE2102 Introduction to Materials Engineering

AP2104/MSE2104 Mechanics of Solids

MA1201 Calculus and Basic Linear Algebra II or

MA2157 Foundation Mathematics and Statistics or

MA2176 Basic Calculus and Linear Algebra

Equivalent Courses

AP3113 Polymer Engineering

Exclusive Courses

Nil

Part II Course Details

Abstract

This course aims to introduce the fundamental concepts and characteristics of soft materials, with a focus on polymer science and its engineering applications. Both synthetic and natural polymers are presented as the primary example of soft matter. The course also includes a broader range of soft materials, such as gels, liquid crystals, and other deformable systems. By exploring the physical and chemical properties of soft materials and their behavior under various conditions, students will learn to identify the relevant principles and apply them to solve practical engineering problems.

Course Intended Learning Outcomes (CILOs)

CILOs		Weighting (if DEC-A1 DEC-A2 DEC-A3 app.)		
1	Demonstrate the macromolecular nature of polymers in industrial applications.			x
2	Identify the importance of additives in plastics formulations.			x
3	Apply the basic theories on the mechanical behaviours of polymers to solve simple engineering (such as deformation and fracture) problems.			x
4	Apply basic rheological theories to solve simple problems in melt characterization and polymer processing.			x
5	Recognize the environmental issues of using polymers in the industry.			x

A1: Attitude

Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability

Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments

Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

LTAs	Brief Description	CILO No.	Hours/week (if applicable)	
1	Lecture / Tutorial	Students will engage in formal lectures and tutorial activities to gain knowledge of the key concepts in polymers in an interactive manner	1, 2, 3, 4, 5	3 hrs/week

2	Laboratory	Students will participate in groups to demonstrate some of the key topics learned in Lecture/Tutorial by experimentation	3, 4	1 hr/week
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Assessment Tasks / Activities (ATs)

ATs	CILO No.	Weighting (%)	Remarks ("- " for nil entry)	Allow Use of GenAI?	
1	Tests	1, 2, 3, 4, 5	20	There will be two tests, each carrying 10%.	No
2	Lab reports	3, 5	20	Students need to complete a number of experiments that demonstrate the principles discussed in lectures/tutorials.	No
3	Presentation	1, 2, 3, 4, 5	10	Students need to make a 10-15-minute presentation related to soft matters.	No

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Minimum Examination Passing Requirement (%)

30

Additional Information for ATs

For a student to pass the course, at least 30% of the maximum mark for the examination must be obtained.

Assessment Rubrics (AR)**Assessment Task**

1. Tests

Criterion

Able to solve numerical problems, and demonstrate the understanding of basic principles

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching the marginal level

Assessment Task

2. Lab reports

Criterion

Ability to explain the methodology and results from experiments

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching the marginal level

Assessment Task

3. Assignments

Criterion

Able to solve numerical problems, and demonstrate the understanding of basic principles

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching the marginal level

Assessment Task

4. Examination

Criterion

Able to solve numerical problems, and demonstrate the understanding of basic principles

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching the marginal level

Part III Other Information

Keyword Syllabus

- Basic concepts of polymer science
Thermoplastics, thermosets and rubbers. Addition, condensation and network polymerization. Molecular weight distribution and their measurement. Amorphous and crystalline polymers. Stereoisomerism. Copolymers.
- Polymer melt rheology
Types of flows: Bulk deformation, elongational flow and shear flow. Non-Newtonian flow. Analysis of simple flows. Rheometry: Melt flow index, capillary rheometer, cone and plate rheometer.
- Polymer processing
Extrusion: Extruder and extrusion dies. Basic consideration on mixing. Single screw and twin screw extruders. Injection moulding: The gate, runner, and mould. Control of pressure, temperature and time. Other processes.
- Rubber elasticity
Models for rubber elasticity. Rubber springs.
- Viscoelasticity
Creep, stress relaxation, and dynamic experiments. Boltzmann superposition principle. Time-temperature superposition.
- Yield and fracture
Shear yielding: Eyring's model, yielding under multiaxial stresses. Impact fracture of polymers. Dynamic critical strain energy release rate.
- Additives
The need for additives. Types of additives. Properties modifications.
- Polymers and their properties
Commodity thermoplastics. Fibres. Elastomers. Thermosets. Engineering polymers. Specialty polymers. Polymer blends.
- Environmental considerations
Plastics recycling. Biodegradable polymers.

Reading List

Compulsory Readings

Title	
1	N G McCrum, C P Buckley and C B Bucknall, "Principles of Polymer Engineering" , 2nd Ed., Oxford Science Publications (1997). (TA455.P58 M334 1997)

Additional Readings

Title	
1	L. H. Sperling, Introduction to Physical Polymer Science (4th Edition), John Wiley & Sons, 2006 (Springer e-book)
2	J R Fried, "Polymer Science and Technology" , Prentice Hall (1995). (QD381.F73 1995)
3	T A Osswald and G Menges, "Materials Science of Polymers for Engineers" , Hanser Publishers (1996). (TA455.P58 O68 1996)